PMT Simulation
sim/data analysis and comparison

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Strategy

For this analysis:

- Based on runs of 55Fe source

- Selected just events with <u>one cluster</u>

- Use PMT + camera reco for data analysis
  Waveform - Image

- **Run 27316: Step 1:** 5.0 cm

- **Run 27317: Step 2:** 15.1 cm

- **Run 27318: Step 3:** 25.1 cm

- **Run 27319: Step 4:** 35.1 cm

- **Run 27320: Step 5:** 46.6 cm

55Fe runs
Daily calibration

Last modification

Amplitude comparison
(centered 6 keV spots at z = 46.6 cm)
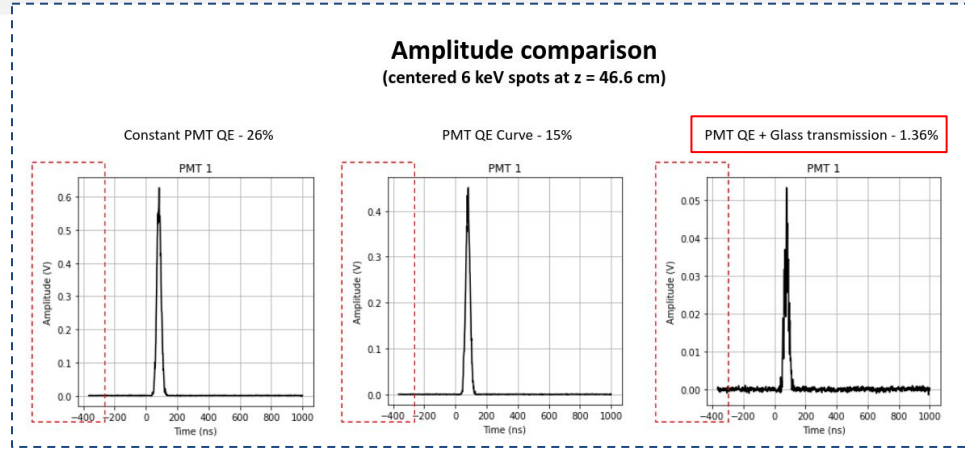
New modification

Important!

- PMT-reco code applies a moving average filter to the waveforms before performing analysis

Redoing simulation vs. real data

Strategy

Points to consider in this analysis:

- Consider the X-Y-Z position of the tracks

- Associate channels with PMTs

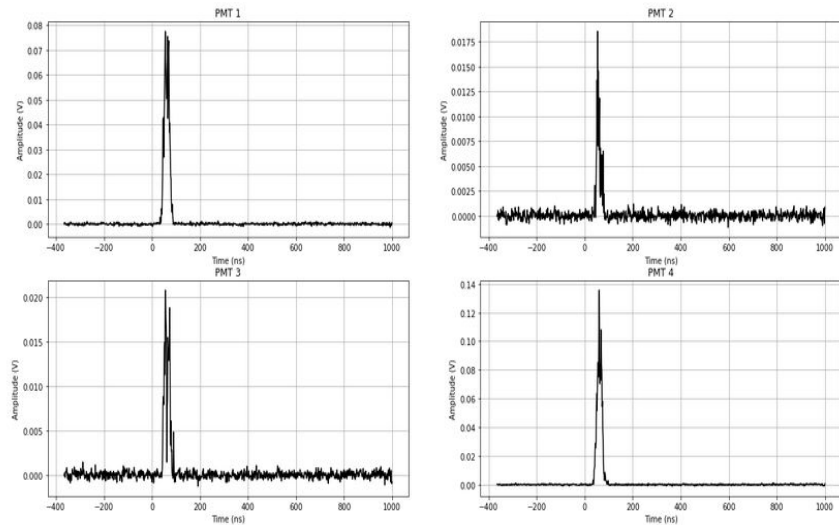- Simulate 6 keV spots

Parameters to be verified:

- Peak

- Integral

- RMSnoise: std of the first 100 samples -> std(waveform[0:100])

- SNR: $\frac{Peak}{RMS_{noise}}$
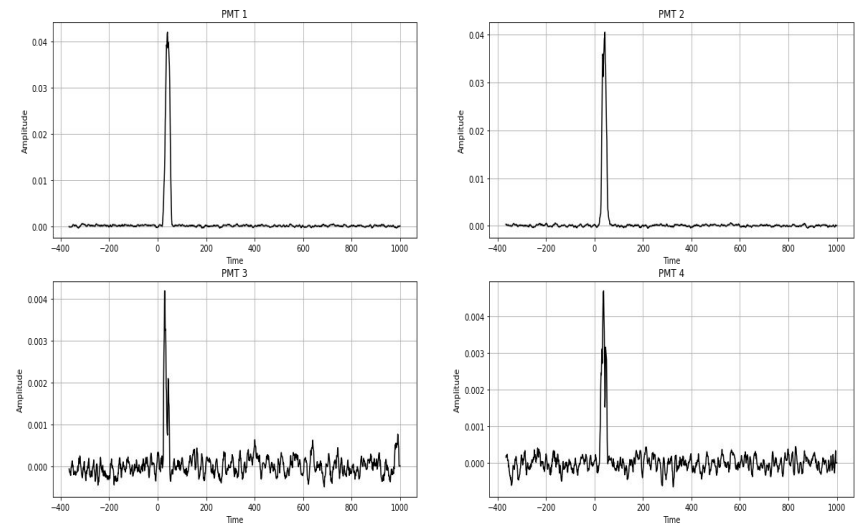
- Full width at half maximum (FWHM)

- Full width

Redoing simulation/data comparison
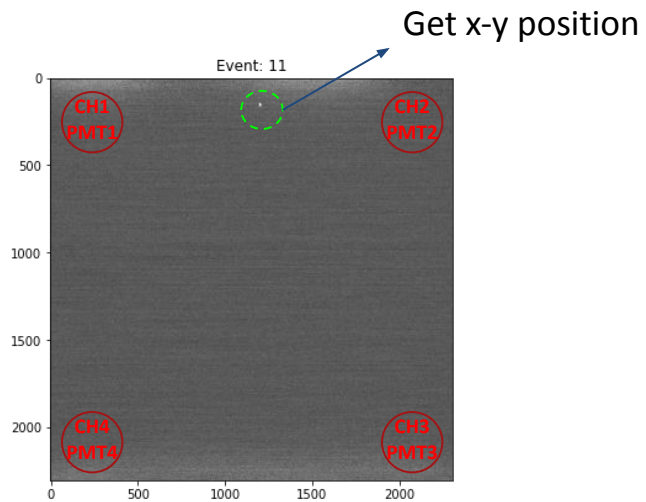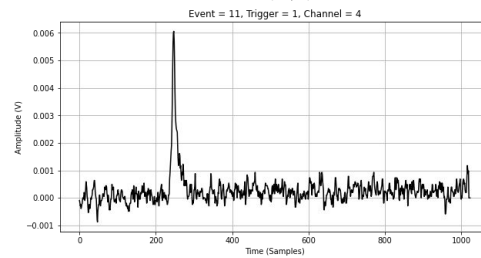
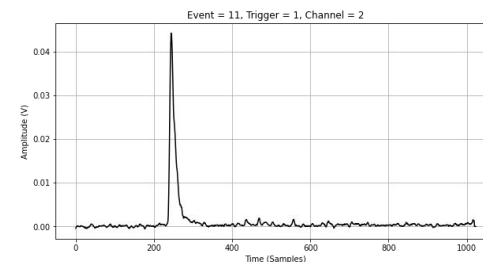# Simulation: before and after the filter

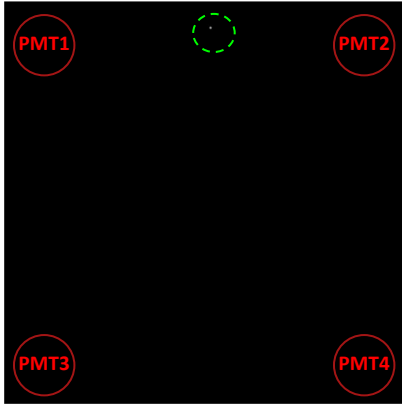**Before filter**

After filter

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Strategy

Sim/data comparison: REAL DATA
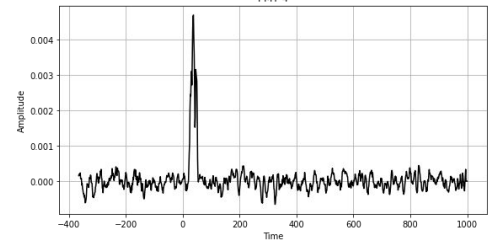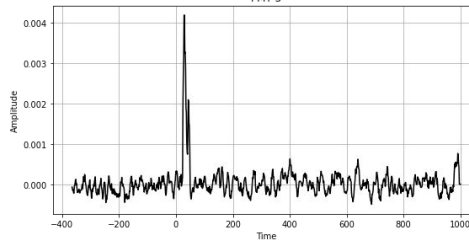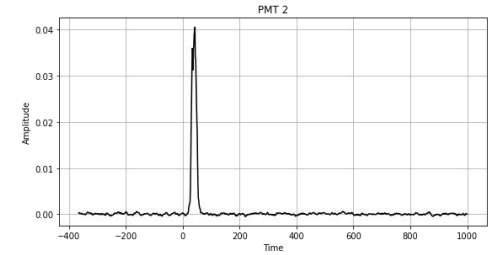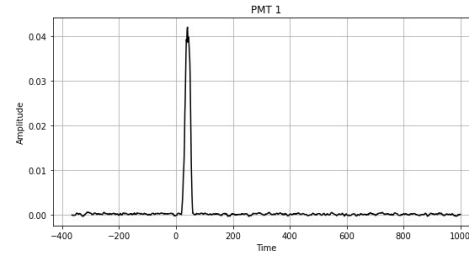
Get x-y position

Get data from waveforms analysis

Sim/data comparison: SIMULATION

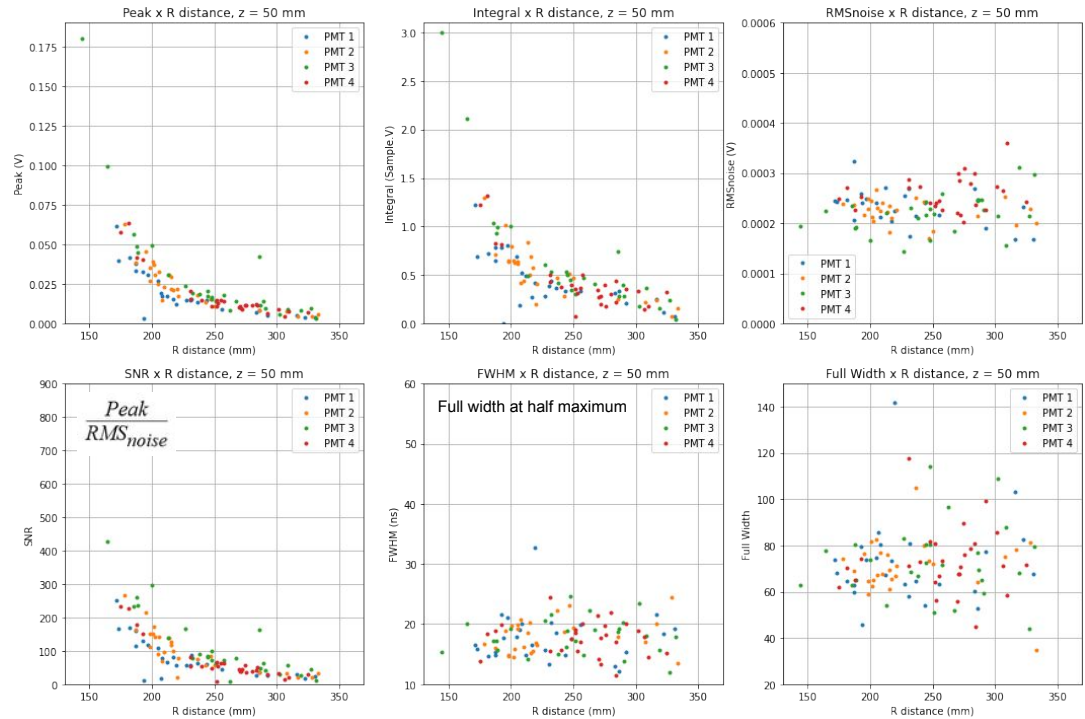Simulate the 6 keV spot at the same position
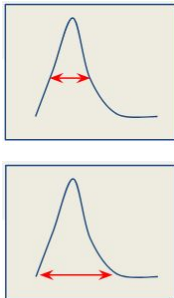
Get data from waveforms analysis

Data analysis results
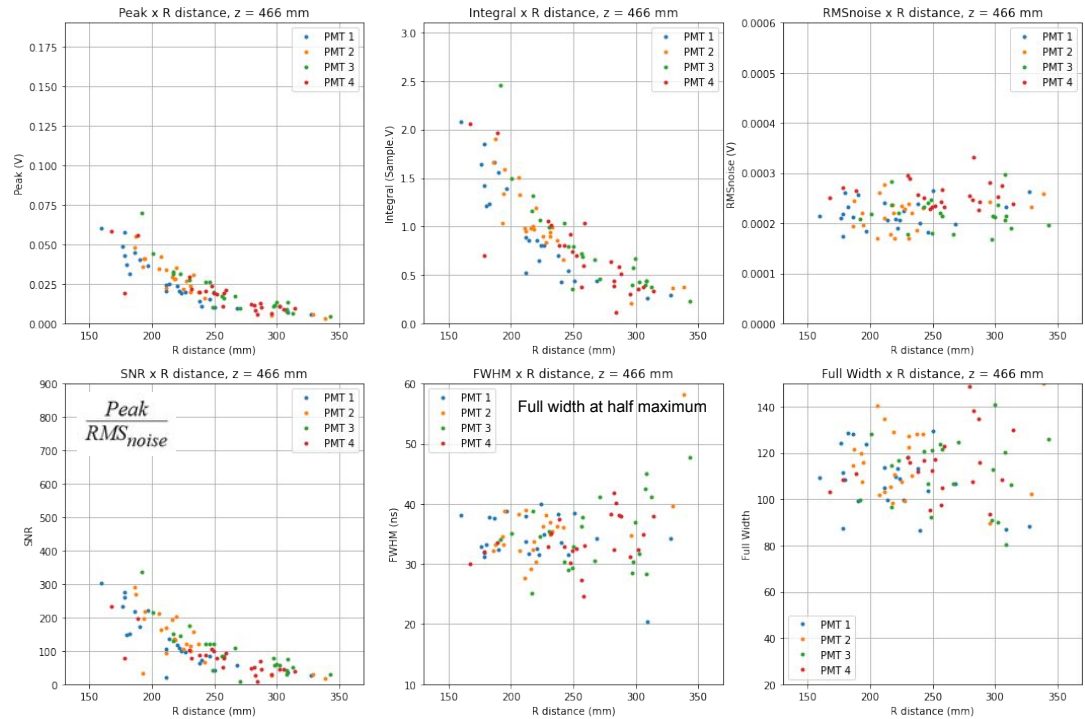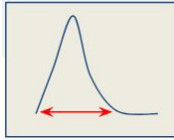
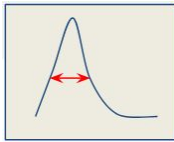## Run 27316 - Step 1: z = 50 mm

Shape parameters

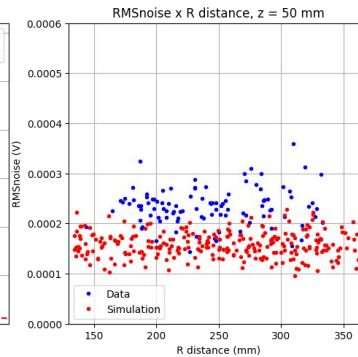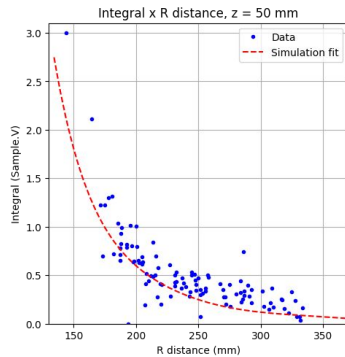# Data analysis results

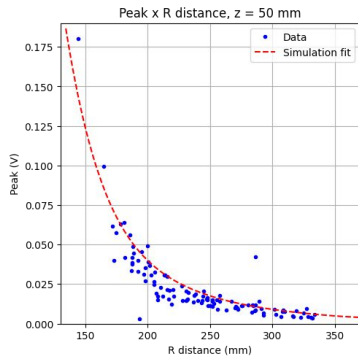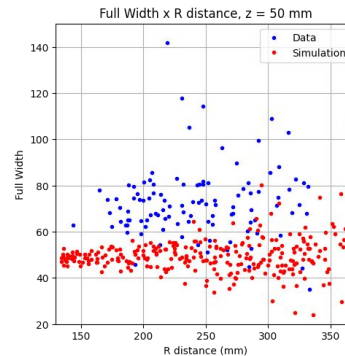**Run 27320 - Step 5: z = 466 mm**
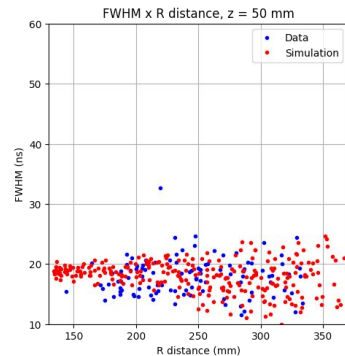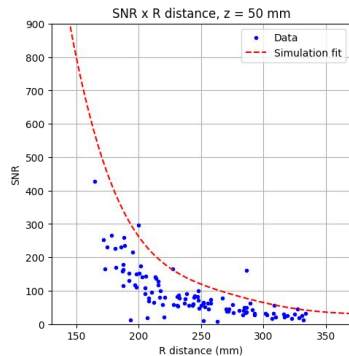

Shape parameters

Sim/data comparison
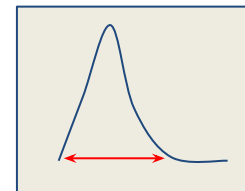
Sim/data comparison: SIMULATION vs. REAL DATA

Run 27316

z = 50 mm

RMS noise

Signal shape

Sim/data comparison

Sim/data comparison: SIMULATION vs. REAL DATA

Run 27320

z = 466 mm
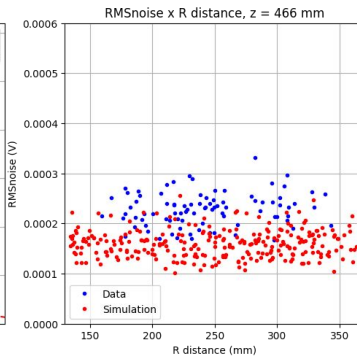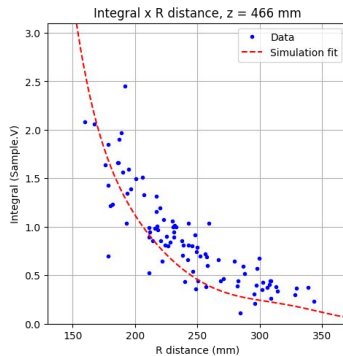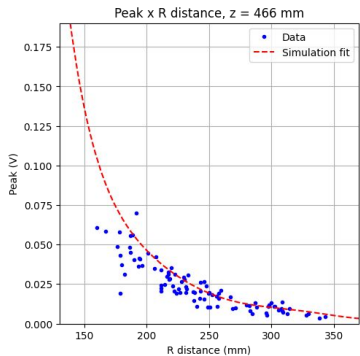
RMS noise
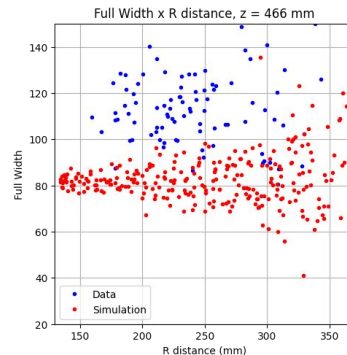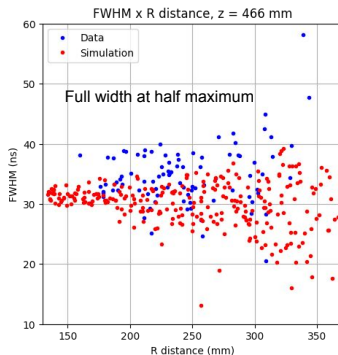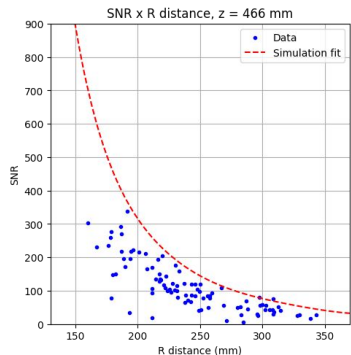
Signal shape
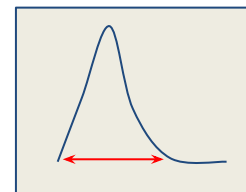
Conclusions

- The simulation is reasonably similar to the data

- Simulation/data main differences:
  - RMS noise (should be easy to solve)
  - Waveform shape (more complicated)

Next steps / on going

- Upload the modifications to the repository

- Fine tuning on the SPE waveform shape

- Simulation for different tracks with different energies and real data comparison

Tasks

Photon propagation method
- Pietro's map
- Photon by photon ✔
- Equation

PMT
- Geometry
- Positions

Detector geometry

Calculate arrival time of each photon that hit the pmt **?**

Photon propagation
INPUT: GEM pos, # of photons for each voxel
OUTPUT: # of hits due each voxel

PMT Characteristics R7378A
- PMT geometry ✔
- Transit time spread ✔
- Quantum efficiency — Electromagnetic spectrum — Applied together with LIME's glass transmision ✔

Tasks

Amplitude distribution

Characterization ✓

Samples correlation

Noise

Digitizer

Fast (1024 Samples, 750Mhz) ✓

Slow (4000 Samples, 250Mhz) **On Going**

PMT Signal
INPUT: # of photons for each voxel, arrival time of each voxel
OUTPUT: signal waveform (amplitude[V] x time[ns])

Charge distribution ✓

SPE Characterization — Amplitude distribution ✓ **On Review**
Very noisy dataset

Shape ✓

Signal

Digitizer

Fast (1024 Samples, 750Mhz) ✓

Slow (4000 Samples, 250Mhz) **On Going**

Tasks